



# CHEMISTRY

12 Advanced

Redox Reactions

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## Sec. (1) Oxidation and Reduction

**Oxidation Number:** The number of electrons lost, gained, or shared from an atom of an element to form a bond.

## Rules for calculating oxidation numbers

## Example

1) The oxidation number of **a pure element** (uncombined) is **zero**

Na, Cl<sub>2</sub>, P<sub>4</sub> = **0**

2) The oxidation number of **a monoatomic ion** is equal to **ion charge**

Ca<sup>2+</sup> = **+2**, Br<sup>-</sup> = **-1**

3) The oxidation number of **fluorine** in its compounds is **-1**

LiF (F = **-1**)

4) The oxidation number of **oxygen** in most of its compounds is **-2**

NO<sub>2</sub> (O = **-2**)

5) The oxidation number of **hydrogen** in most of its compounds is **+1**

H<sub>2</sub>CO<sub>3</sub> (H = **+1**)

6) The oxidation number of **group 1 metals** in their compounds is **+1**

LiBr (Li = **+1**)

7) The oxidation number of **group 2 metals** in their compounds is **+2**

MgSO<sub>4</sub> (Mg = **+2**)

8) The oxidation number of **aluminum** in its compounds is **+3**

Al<sub>2</sub>O<sub>3</sub> (Al = **+3**)

Why is the oxidation number -2 not used for oxygen if the oxidation number of oxygen is to be calculated?

Because oxygen has special cases of oxidation numbers.

Why is the oxidation number +1 not used for hydrogen if the oxidation number of hydrogen is to be calculated?

Because hydrogen has special cases of oxidation numbers.

The oxidation number of Cl, Br, I in their compounds is -1 (if they are the highest electronegativity in the compound or to the right side in the compound)

The sum of the oxidation numbers of neutral compounds is zero.

The sum of the oxidation numbers of a polyatomic ion is equal to the charge of the ion.





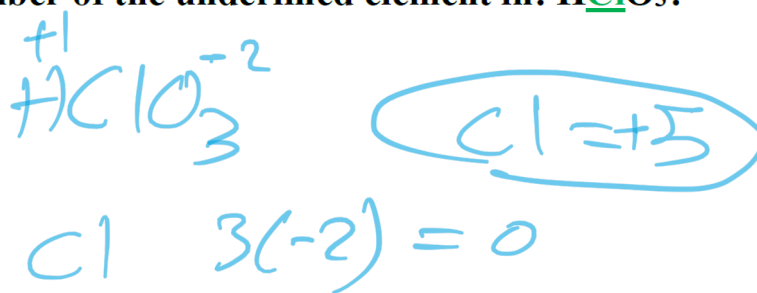
1) What is the oxidation number of the underlined element in:  $\text{H}\underline{\text{Cl}}\text{O}_3$ ?

a. +3

b. -3

c. +5

d. -5



2) What is the oxidation number of the underlined element in:  $\underline{\text{S}}\text{O}_3^{2-}$ ?

a. +4

b. +6

c. +3

d. +1

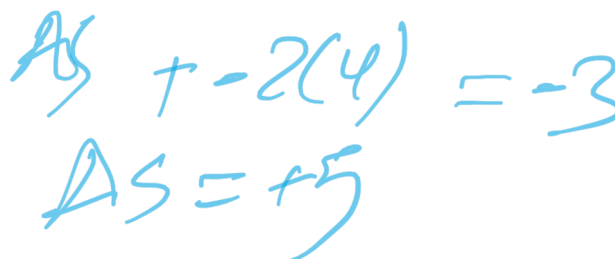
3) What is the oxidation number of the underlined element in:  $\underline{\text{As}}\text{O}_4^{3-}$ ?

a. -8

b. +5

c. -5

d. +8



4) What is the oxidation number of the underlined element in:  $\underline{\text{N}}\text{H}_4^+$ ?

a. +1

b. -1

c. -3

d. +4

5) What is the oxidation number of the underlined element in:  $\text{Na}\underline{\text{Cl}}\text{O}_4$ ?

a. +7

b. +5

c. +3

d. +1





6) What is the oxidation number of the underlined element in:  $\text{Cr}_2\text{O}_7^{2-}$ ?

- a. +7
- b. +4
- c. +12
- d. +6

7) What is the oxidation number of the underlined element in:  $\text{AlPO}_4$ ?

- a. +5
- b. +8
- c. -5
- d. +4

8) What is the oxidation number of the underlined element in:  $\text{Ca}_3\text{N}_2$ ?

- a. +2
- b. -3
- c. +3
- d. -2

9) What is the oxidation number of the underlined element in:  $\text{B}_4\text{O}_7^{2-}$ ?

- a. +1
- b. +6
- c. +3
- d. -3

10) What is the oxidation number of the underlined element in:  $\text{KBr}$ ?

- a. -1
- b. +1
- c. -2
- d. +2



11) What is the oxidation number of the underlined element in:  $\text{H}\underline{\text{N}}\text{O}_3$ ?

- a. +5
- b. +3
- c. +1
- d. +2

12) What is the oxidation number of the underlined element in:  $\underline{\text{I}}\text{O}_4^-$ ?

- a. +1
- b. +5
- c. +7
- d. +3

13) What is the oxidation number of the underlined element in:  $\underline{\text{Mn}}\text{O}_4^-$ ?

- a. +4
- b. +3
- c. +5
- d. +7

14) What is the oxidation number of the underlined element in:  $\underline{\text{Sb}}_2\text{O}_5$ ?

- a. 0
- b. +5
- c. +2
- d. -5

15) What is the oxidation number of the underlined element in:  $\underline{\text{W}}\text{O}_4^{2-}$ ?

- a. +8
- b. +6
- c. +4
- d. +2





16) What is the oxidation number of the underlined element in:  $\underline{\text{N}}\text{H}_2^-$ ?

- a. +2
- b. -1
- c. -2
- d. -3

17) What is the oxidation number of the underlined element in:  $\text{Ca}\underline{\text{Cr}}\text{O}_4$ ?

- a. +6
- b. +4
- c. +8
- d. +2

18) What is the oxidation number of the underlined element in:  $\text{NaH}\underline{\text{S}}\text{O}_4$ ?

- a. +1
- b. +4
- c. +6
- d. -6

19) What is the oxidation number of the underlined element in:  $\text{Fe}(\underline{\text{N}}\text{O}_3)_2$ ?

- a. +5
- b. +2
- c. +3
- d. +4

11	a	12	c	13	d	14	b	15	b
16	d	17	a	18	c	19	a		





20) Which of the following substances has an oxidation number of **nitrogen** = +3?

- a.  $\text{NH}_3$
- b.  $\text{N}_2\text{O}_4$
- c.  $\text{NO}_3^-$
- d.  $\text{NO}_2^-$

21) Which of the following substances has an oxidation number of **bromine** = +5?

- a.  $\text{BrO}_2^-$
- b.  $\text{BrO}_3^-$
- c.  $\text{BrO}_4^-$
- d.  $\text{BrO}^-$

22) Which of the following substances has an oxidation number of **oxygen** = -1?

- a.  $\text{O}_2$
- b.  $\text{H}_2\text{O}$
- c.  $\text{OF}_2$
- d.  $\text{BaO}_2$

23) Which of the following substances has an oxidation number of **carbon** = 0?

- a.  $\text{C}_2\text{O}_4^{2-}$
- b.  $\text{C}_6\text{H}_{12}\text{O}_6$
- c.  $\text{H}_2\text{CO}_3$
- d.  $\text{CH}_4$

24) Which of the following substances has an oxidation number of **hydrogen** = -1?

- a.  $\text{OH}^-$
- b.  $\text{HCl}$
- c.  $\text{H}_2\text{O}$
- d.  $\text{KH}$





## Oxidation and Reduction

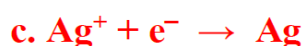
**Oxidation reaction:** A reaction in which a reactant loses electrons.

$e^-$  with products

**Reduction reaction:** A reaction in which a reactant gains electrons.

$e^-$  with reactants

25) Which of the following half-reactions represents an **oxidation** process?



26) Which of the following half-reactions represents a **reduction** process?



## Change in oxidation number

**Oxidation reaction:** A reaction in which the oxidation number increases.

The oxidation number of the element in the reactants < products

**Reduction reaction:** A reaction in which the oxidation number decreases.

The oxidation number of the element in the reactants > products

**Oxidation-reduction reaction:** The reaction in which electrons are transferred from one substance to another.

or

The reaction during which the oxidation number changes.

or

A reaction in which electrons are shared between atoms.



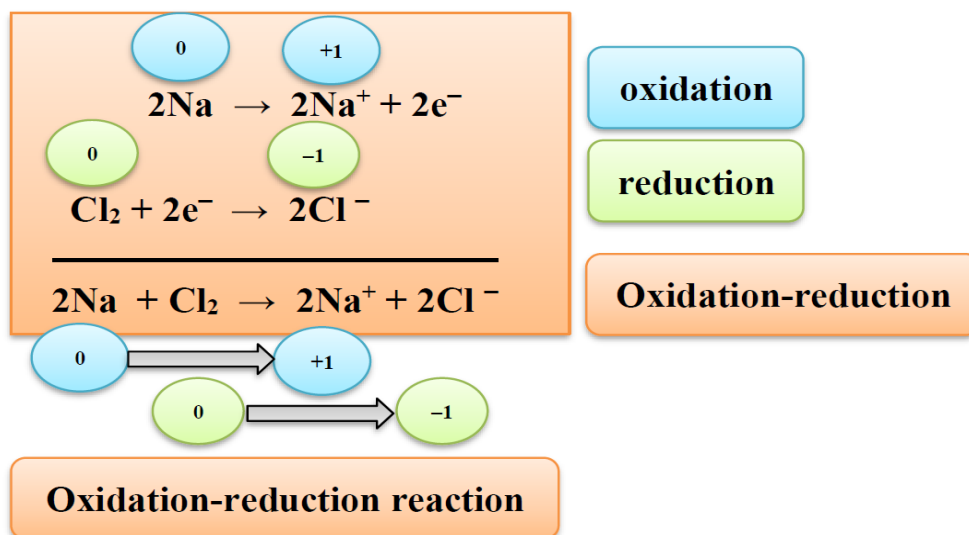




The union of a substance with oxygen is also one of the definitions of oxidation.

Oxidation and reduction are concomitant processes, (oxidation cannot occur unless reduction also occurs).

number of lost electrons = number of gained electrons



Why do metals have positive oxidation numbers?

Because the electronegativity of metals is low, they lose electrons.

Why do nonmetals have negative oxidation numbers?

Because the electronegativity of nonmetals is high, they gain electrons.

The light from the party sticks results from a chemical reaction. When the glass capsule is broken inside the plastic tube, a reaction occurs between two chemicals and electrons are transferred, turning the chemical energy into light.



Why are combustion and single replacement reactions a reaction?

Because the oxidation number changes during the reaction.

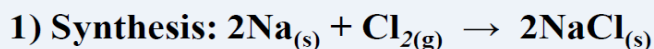
Why are double replacement reactions not an oxidation-reduction reaction?

Because the oxidation number does not change during the reaction.

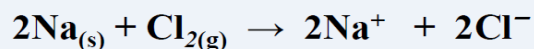
When do synthesis and decomposition reactions represent an oxidation-reduction reaction?

If the oxidation number changes during the reaction.





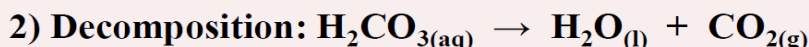
has the net ionic equation



represents oxidation-reduction reaction

oxidation  
numbers changes

2 electrons are transferred  
from the sodium atoms to  
the chlorine molecule

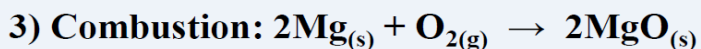


does not represent oxidation-reduction reaction

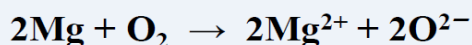
No transfer of electrons  
occurs during the reaction

The oxidation numbers of  
the elements do not  
change during the reaction

No sharing of electrons  
occurs during the reaction



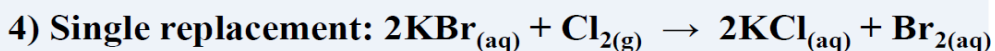
has the net ionic equation



represents oxidation-reduction reaction

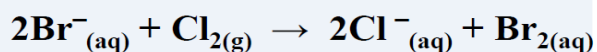
oxidation  
numbers changes

One atom of magnesium gives 2  
electrons to each oxygen atom



$\text{K}^+$ : spectator  
ion

has the net ionic equation

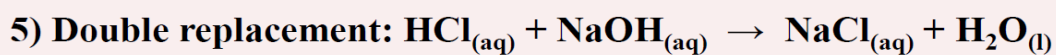


represents oxidation-reduction reaction

oxidation  
numbers changes

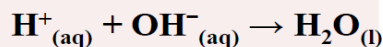
2 electrons are transferred  
from the bromide ion to the  
chlorine molecule





$\text{Na}^+$ ,  $\text{Cl}^-$ :  
spectator ions

has the net ionic equation



does not represent oxidation-reduction reaction

No transfer of  
electrons occurs

The oxidation  
numbers does  
not change

No sharing of  
electrons occurs

27) Why does the oxidation number decrease in a reduction reaction?

- a. gaining electrons
- b. losing electrons
- c. addition of  $\text{OH}^-$  ions
- d. addition of  $\text{H}_3\text{O}^+$  ions

28) In the half-reaction:  $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ , why do silver ions change into silver atoms?

- a. silver ions ionized
- b. silver ions are oxidized
- c. silver ions are reduced
- d. the oxidation number of silver ions does not change

29) In an oxidation-reduction reaction,  $\text{CO}$  turns into  $\text{CO}_2$ , how many electrons are lost or gained from  $\text{C}$ ?

- a. lose one electron
- b. lose two electrons
- c. gain one electron
- d. gain two electrons

30) In an oxidation-reduction reaction,  $\text{MnO}_4^-$  turns into  $\text{MnO}_4^{2-}$ , how many electrons are gained or lost from  $\text{Mn}$ ?

- a. lose one electron
- b. lose two electrons
- c. gain one electron
- d. gain two electrons





31) In the reaction:  $2\text{K} + \text{Br}_2 \rightarrow 2\text{K}^+ + 2\text{Br}^-$ , which species is **reduced**?

- a. K
- b.  $\text{Br}_2$
- c.  $\text{K}^+$
- d.  $\text{Br}^-$

32) Which of the following changes represents an **oxidation** process?

- a.  $\text{ClO}^- \rightarrow \text{Cl}^-$
- b.  $\text{VO}^{2+} \rightarrow \text{VO}_3^-$
- c.  $\text{NO}_2^- \rightarrow \text{N}_2$
- d.  $\text{CrO}_4^{2-} \rightarrow \text{Cr}_2\text{O}_7^{2-}$

33) Which of the following changes represents a **reduction** process?

- a.  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$
- b.  $\text{NH}_3 \rightarrow \text{NO}_2$
- c.  $\text{Cr}_2\text{O}_7^{2-} \rightarrow \text{Cr}^{3+}$
- d.  $\text{H}_2\text{S} \rightarrow \text{SO}_4^{2-}$

34) What is the total number of electrons transferred during the balanced reaction?



- a. a transfer of 2 electrons from Na to  $\text{H}^+$
- b. a transfer of 1 electron from Na to  $\text{H}^+$
- c. a transfer of 2 electrons from  $\text{H}^+$  to Na
- d. a transfer of 1 electron from  $\text{H}^+$  to Na

35) What is the total number of electrons transferred during the balanced reaction?



- a. a transfer of 3 electrons from Ce to  $\text{Cu}^{2+}$
- b. a transfer of 6 electrons from Ce to  $\text{Cu}^{2+}$
- c. a transfer of 3 electrons from  $\text{Cu}^{2+}$  to Ce
- d. a transfer of 6 electrons from  $\text{Cu}^{2+}$  to Ce





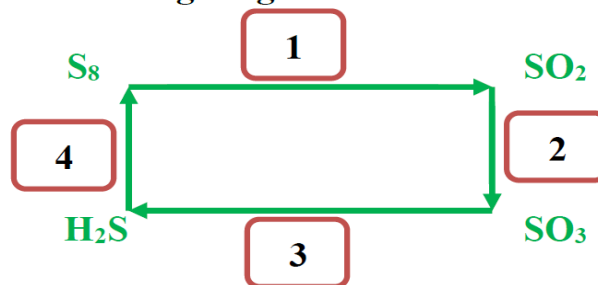
36) What step represents the reduction process in the following diagram?

a. 1

b. 2

c. 3

d. 4



37) Which of the following reactions is an oxidation-reduction reaction?

a.  $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$

b.  $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

c.  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

d.  $\text{AgNO}_3 + \text{NaBr} \rightarrow \text{NaNO}_3 + \text{AgBr}$

38) Which of the following reactions is **not** an oxidation-reduction reaction?

a.  $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$

b.  $\text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{H}_2\text{SO}_3$

c.  $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$

d.  $2\text{NaBr} + \text{Cl}_2 \rightarrow 2\text{NaCl} + \text{Br}_2$

39) Which of the following statements is **incorrect** for the reaction?



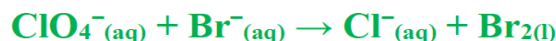
a. the oxidation number of nitrogen changes from  $-3$  to  $+1$

b. the oxidation number of nitrogen changes from  $+5$  to  $+1$

c. does not represent an oxidation-reduction reaction

d. the oxidation number of nitrogen in  $\text{N}_2\text{O}$  is  $+1$

40) Which of the following statements is true for the following redox reaction?



a. the oxidation number of Cl changes from  $-1$  to  $+4$

b. the oxidation number of Cl changes from  $-1$  to zero

c. the oxidation number of Br changes from  $-1$  to zero

d. the oxidation number of Br changes from  $-1$  to  $2$





41) Which of the following half-reactions represents a **reduction** process?

- a.  $\text{H}_2\text{S} \rightarrow \text{S} + 2\text{e}^- + 2\text{H}^+$
- b.  $\text{SO}_2 + 4\text{e}^- + 2\text{H}_2\text{O} \rightarrow \text{S} + 4\text{OH}^-$
- c.  $[\text{Mn}(\text{CN})_6]^{4-} \rightarrow [\text{Mn}(\text{CN})_6]^{3-} + \text{e}^-$
- d.  $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$

42) Which of the following is **reduced** in the reaction?  $2\text{Al} + 3\text{Cu}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Cu}$

- a.  $\text{Al}^{3+}$
- b.  $\text{Al}$
- c.  $\text{Cu}^{2+}$
- d.  $\text{Cu}$

43) In an oxidation-reduction reaction,  $\text{MnO}_4^-$  turns into  $\text{Mn}^{2+}$ , how many electrons are lost or gained from Mn?

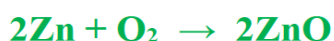
- a. lose 2 electrons
- b. lose 5 electrons
- c. gain 2 electrons
- d. gain 5 electrons

44) How many electrons are transferred in the balanced reaction?



- a. a transfer of 1 electron from  $\text{Br}^-$  to  $\text{Cl}_2$
- b. a transfer of 2 electrons from  $\text{Br}^-$  to  $\text{Cl}_2$
- c. a transfer of 1 electron from  $\text{Cl}_2$  to  $\text{Br}^-$
- d. a transfer of 2 electrons from  $\text{Cl}_2$  to  $\text{Br}^-$

45) Which of the following statements is true for the oxidation-reduction reaction?



- a. the oxidation number of O changes from 0 to -1
- b. the oxidation number of O changes from -2 to 0
- c. the oxidation number of Zn changes from 0 to +2
- d. the oxidation number of Zn changes from +1 to 0

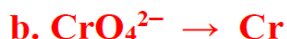




46) What is the spectator ion in the reaction?  $\text{MgI}_2 + \text{Br}_2 \rightarrow \text{MgBr}_2 + \text{I}_2$



47) Which of the following changes represents an **oxidation** reaction?



48) Which of the following reactions is **not** an oxidation-reduction reaction?



49) What is the total change in the oxidation number of **chlorine** in the following redox reaction?  $\text{ClO}_3^- + 6\text{Fe}^{2+} + 6\text{H}^+ \rightarrow \text{Cl}^- + 6\text{Fe}^{3+} + 3\text{H}_2\text{O}$

a. -1

b. -6

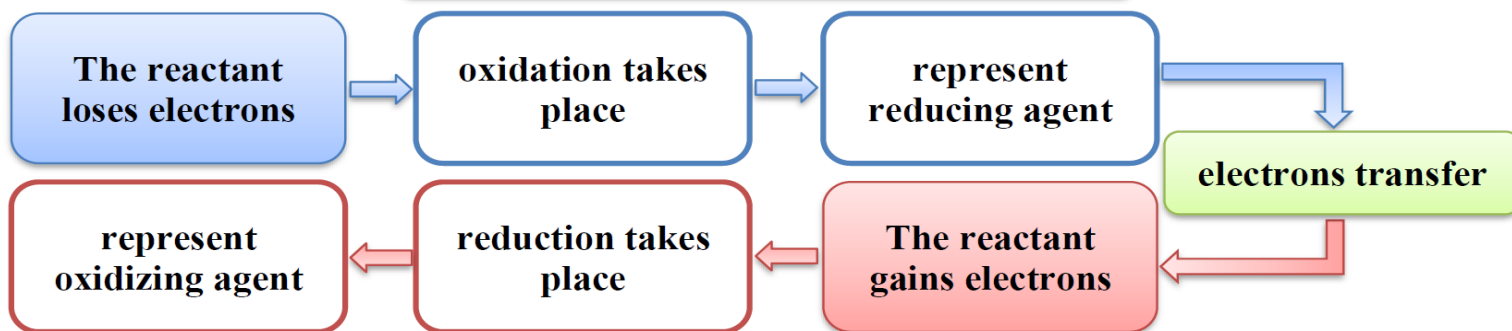
c. 0

d. -5

41	b	42	c	43	d	44	b	45	c
46	a	47	c	48	a	49	b		

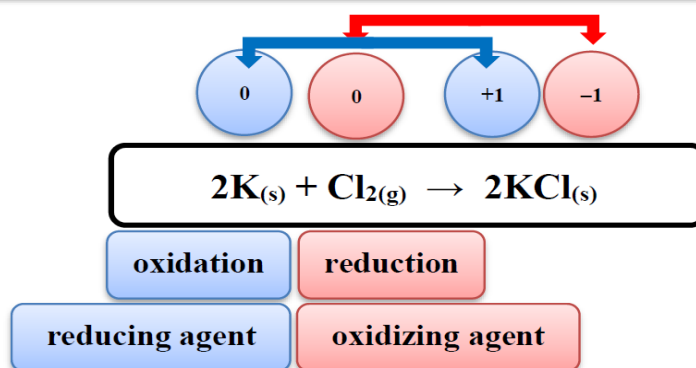




**Oxidizing agents and reducing agents**

**Reducing agent:** A substance that reduces another substance by losing electrons.

**Oxidizing agent:** A substance that oxidizes another substance by gaining electrons.



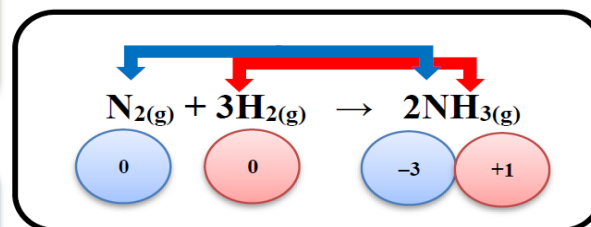
Electrons transfers from the reducing agent to the oxidizing agent.

Using NaClO sodium hypochlorite laundry bleach leads to the oxidation of stains and dyes, as it is an oxidizing agent.

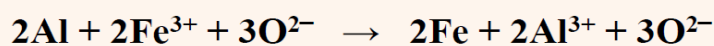
Some redox reactions involve changes in the oxidation number of compounds in which the bonds are covalent.

The reaction to form ammonia is an oxidation-reduction reaction, even though the reactants and products are molecular compounds?

Because one of the atoms lost electrons(H), and the other atom gained electrons (N).







The oxidation number of Al changes from 0 to +3

oxidation takes place

Al: reducing agent

The oxidation number of  $\text{Fe}^{3+}$  changes from +3 to 0

reduction takes place

$\text{Fe}^{3+}$ : oxidizing agent

The oxidation number of  $\text{O}^{2-}$  does not change

no oxidation,  
no reduction

$\text{O}^{2-}$ : spectator ion

50) What is the reducing agent, the oxidizing agent in the reaction?



choice	reducing agent	oxidizing agent
a.	$\text{Fe}^{2+}$	Ag
b.	Ag	$\text{Fe}^{2+}$
c.	Fe	$\text{Ag}^+$
d.	$\text{Ag}^+$	Fe

51) What is the reducing agent in the reaction?  $2\text{Fe}_{(s)} + 6\text{HBr}_{(aq)} \rightarrow 2\text{FeBr}_{3(s)} + 3\text{H}_{2(g)}$

- a.  $\text{H}_2$
- b. Fe
- c. HBr
- d.  $\text{FeBr}_3$

52) What is the oxidizing agent in the reaction?  $\text{H}_2\text{S} + \text{Cl}_2 \rightarrow \text{S} + 2\text{HCl}$

- a.  $\text{Cl}_2$
- b.  $\text{H}_2\text{S}$
- c. S
- d. HCl





53) Which of the following statements is true for the reaction?  $\text{Mg} + \text{I}_2 \rightarrow \text{MgI}_2$

- a. the oxidation number of I changes from 0 to -2
- b. the oxidation number of Mg changes from 0 to +1
- c.  $\text{I}_2$  represents spectator ion
- d. Mg is a reducing agent

54) What is the reducing agent in the reaction?



- a.  $\text{H}^+$
- b. Sn
- c.  $\text{Cl}^-$
- d.  $\text{NO}_3^-$

55) What is the oxidizing agent in the reaction?  $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$

- a.  $\text{O}_2$
- b.  $\text{NH}_3$
- c.  $\text{H}_2\text{O}$
- d. NO

56) Which of the following statements is true for the reaction?



- a. the oxidation number of Ag increases during the reaction
- b. an oxidation process of  $\text{Ag}^+$  takes place
- c. Mg represents a stronger oxidizing agent than Ag
- d. Mg is a stronger reducing agent than Ag

57) What does oxygen represent when hydrogen peroxide is decomposed?



- a. a reducing agent only
- b. an oxidizing agent only
- c. reducing agent and oxidizing agent
- d. does not represent a reducing agent or an oxidizing agent

54

b

55

a

56

d

57

c





## 2021-2022 Exam Questions

1. Which of the following is true for the reaction:  $2\text{K}_{(\text{s})} + \text{F}_{2(\text{g})} \rightarrow 2\text{KF}_{(\text{s})}$ ?

- a. potassium atom, K, has gained an electron and is reduced
- b. fluorine  $\text{F}_2$  gained electrons and oxidized
- c. potassium atom, K, has lost an electron and has oxidized
- d. fluorine  $\text{F}_2$  lost electrons and oxidized

2. What is the reducing agent in the following reaction?



- a. S
- b. HCl
- c.  $\text{H}_2\text{S}$
- d.  $\text{Cl}_2$

3. What is the correct ascending order of the following formulas according to the oxidation number of **chlorine** in each?



- a.  $\text{NaCl} \rightarrow \text{Cl}_2 \rightarrow \text{KClO} \rightarrow \text{KClO}_4$
- b.  $\text{Cl}_2 \rightarrow \text{NaCl} \rightarrow \text{KClO}_4 \rightarrow \text{KClO}$
- c.  $\text{KClO}_4 \rightarrow \text{KClO} \rightarrow \text{Cl}_2 \rightarrow \text{NaCl}$
- d.  $\text{KClO}_4 \rightarrow \text{NaCl} \rightarrow \text{Cl}_2 \rightarrow \text{KClO}$

1	c	2	c	3	a				
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## Sec. (2) Balancing Redox Equations

## Balancing Redox Equations using half-reactions method

1) Calculate the oxidation numbers of atoms in the equation.

Using the rules for the oxidation number.

2) Write the half- reactions.

Oxidation half-reaction, half-reduction reaction.

3) Balance each half-reaction individually.

a) Balance the atoms whose oxidation number changes.

By adding coefficients to the elements whose oxidation number has changed.

b) Balance of oxygen.

Add  $\text{H}_2\text{O}$  to balance the difference in oxygen atoms between the two sides.

c) Balance of hydrogen.

Add  $\text{H}^+$  to balance the difference in hydrogen atoms between the two sides.

d) Balance the charge.

Add  $e^-$  to balance the change in oxidation number of the element in the equation.

4) Equal of charge.

Number of lost electrons = number of gained electrons

5) Get the balanced equation.

Subtract the same types on two different sides, add the same types on the same side.

6) Check the balance.

The number of atoms and the charges on both sides are equal.

## Balancing Redox Equations in basic solution

Add the number of  $\text{OH}^-$  equal to the number of  $\text{H}^+$  in the final balanced equation, to get  $\text{H}_2\text{O}$



x mol

x mol

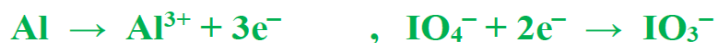
x mol

The  $\text{H}_2\text{O}$  molecules produced at both ends can be canceled to obtain a balanced equation in a basic solution.





58) What is the balanced equation for the following half-reactions? (in **acidic** solution)



59) What is the balanced equation for the following half-reactions? (in **acidic** solution)





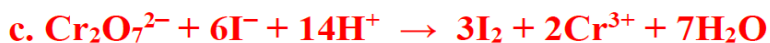
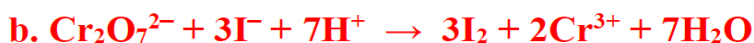
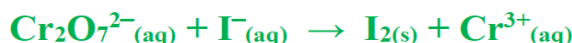
60) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)



61) What is the balanced equation for the following redox equation?

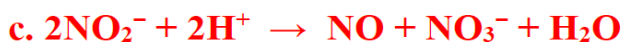
(using half-reactions method, in **acidic** solution)





62) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)



63) What is the balanced equation for the following redox equation?

(using half-reactions method, in **basic** solution)





64) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)



65) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)

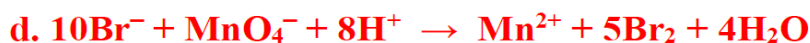
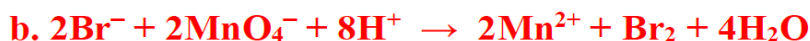






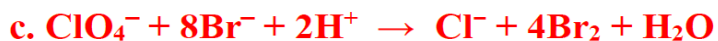
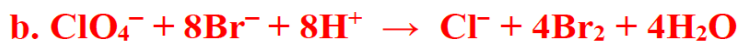
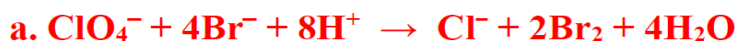
66) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)



67) What is the balanced equation for the following redox equation?

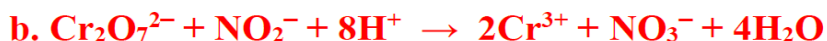
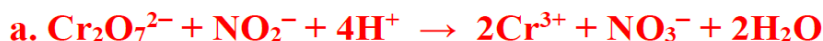
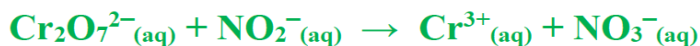
(using half-reactions method, in **acidic** solution)





68) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)



69) What is the balanced equation for the following redox equation?

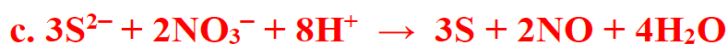
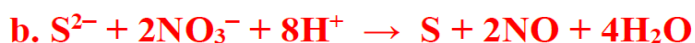
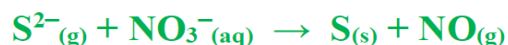
(using half-reactions method, in **basic** solution)





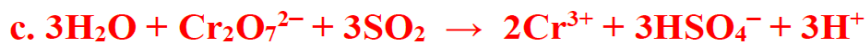
70) What is the balanced equation for the following redox equation?

(using half-reactions method, in **acidic** solution)



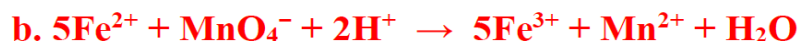
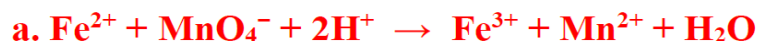
71) What is the balanced equation for the following redox equation?

(using half-reactions method, in **basic** solution)





72) What is the balanced oxidation-reduction equation for the following half-reactions?



73) What is the balanced equation for the following redox equation?

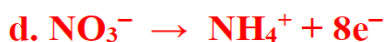
(using half-reactions method, in **acidic** solution)





74) In the following half-reaction,  $\text{NO}_3^- \rightarrow \text{NH}_4^+$

how many electrons must be added to balance the charge?



75) What must be added to the oxidation-reduction equation that occurs in an acidic medium in order for it to be balanced?



76) What is the value of **X** in the equation for the next half-reaction until the equation is balanced?



a. 5

b. 1

c. 2

d. 10

64	a	65	b	66	a	67	b	68	c
69	b	70	c	71	a	72	d	73	c
74	b	75	b	76	a				



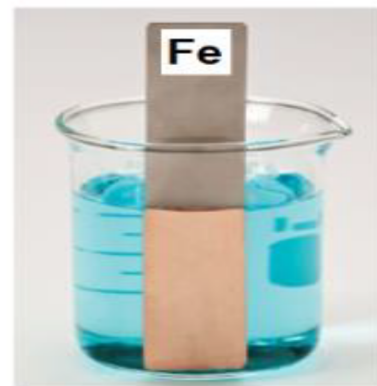
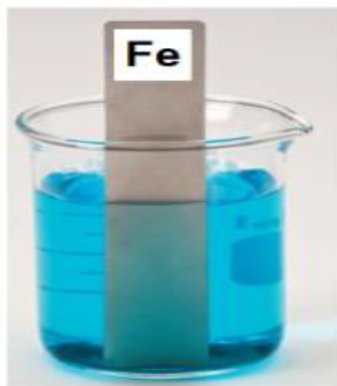


## 2021-2022 Exam Questions

1. The reaction between nickel and copper (II) chloride shown below, what we describe as redox reactions:  $\text{Ni}_{(s)} + \text{CuCl}_{2(aq)} \rightarrow \text{Cu}_{(s)} + \text{NiCl}_{2(aq)}$ ?

	oxidation half-reaction	reduction half-reaction
A	$\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$	$\text{Cl}_2 \rightarrow 2\text{Cl}^- + 2\text{e}^-$
B	$\text{Ni} \rightarrow \text{Ni}^{2+} + \text{e}^-$	$\text{Cu}^+ + \text{e}^- \rightarrow \text{Cu}$
C	$\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
D	$\text{Cu}^+ + \text{e}^- \rightarrow \text{Cu}$	$\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$

- a. B  
b. D  
c. A  
d. C
2. An iron plate was placed in a copper (II) sulfate solution as shown in the figure below. Why did the iron plate change color?

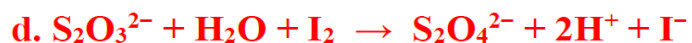
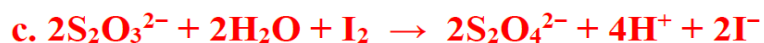


- a. iron (III) ions are oxidized by losing electrons  
b. . reduction of copper (II) ions and copper deposition on the iron plate  
c. reduction of iron (III) ions by gaining electrons  
d. oxidation of copper atoms to copper (II) ions





3. Using the half-reaction method to weigh redox reactions, what is the correct balanced equation for the following reaction in an **acidic** solution?



1	d	2	b	3	b				
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